END
DATE
FILMED
8-8
DTI

1.0

1.1

1.25   1.4   1.6

4.5
5.0
5.6
6.3

2.8   2.5
3.2   2.2
3.6   2.0
4.0   1.8

MICROCOPY RESOLUTION TEST CHART

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**US Army Corps
of Engineers**
The Hydrologic
Engineering Center

Application of

the HEC-2

Split Flow Option

Training Document No. 18

April 1982

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Training document designed to assist the user of computer program HEC-2 split flow option and to acquaint them with its capabilities and limitations. Provide a detailed description of the HEC-2 split flow input requirements, output results, computation method and example applications.

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TRAINING DOCUMENT NO. 18

APPLICATION OF THE HEC-2 SPLIT FLOW OPTION

Alfredo E. Montalvo

April 1982

U. S. Army Corps of Engineers
Water Resources Support Center
The Hydrologic Engineering Center
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FOREWORD

This training document was written to assist users of Computer Program HEC-2, Water Surface Profiles, in the analysis of split flows. Financial assistance for writing this document was provided by the Flood Plain Management Branch, Office of the Chief of Engineers.

The author wishes to acknowledge contributions by Vernon R. Bonner and Bill S. Eichert to the material contained in this document and for their reviews and comments.

TABLE OF CONTENTS

APPLICATION OF THE HEC-2 SPLIT FLOW OPTION

INTRODUCTION

Purpose and Scope.

The purpose of this training document is to provide information on the capabilities and limitations of the computer program HEC-2 Split Flow option. This document provides a detailed description of the input requirements, output results, computational methods and example applications for the split flow option. It is assumed that the user has a knowledge of the basic HEC-2 input requirements. Information on HEC-2 input requirements is available in the "HEC-2 Water Surface Profiles-Users Manual" (reference 1).

Program Documentation.

The split flow option was added to the HEC-2 Computer Program by Modification 55 which was implemented April 1982. The primary documentation for HEC-2 is the January 1981 Users Manual which describes the program capabilities, input requirements, and output. To use the program, one would need a users manual, as this document does not give details on many program features and input formats. The users manual is available from the Hydrologic Engineering Center.

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HEC-2 SPLIT FLOW OPTION

Split flows are flows that leave the main river flow and take completely separate paths from the path taken by the main river flow. The split flows may return further downstream or may be completely lost. The HEC-2 program assumes that none of the split flows return and automatically reduces the discharges downstream from the split flow location unless the user specifies where to return the flow and what percent of it to return.

Capabilities.

The HEC-2 split flow option has the following capabilities:

- Can solve up to 100 separate split flows simultaneously.
- Up to 15 profiles may be solved in one execution.
- Three methods for determining the split flows are available.
  1. Weir flow assumption
  2. Normal depth assumption
  3. Rating curve assumption
- All or a percentage of the split flow can be returned.
- Option of either using the water surface or energy elevation for computing the split flows.
- Allows the use of rating curves for starting the backwater. This capability is now a general HEC-2 capability and may be used without having to use the split flow option.

The split flow option is compatable with multiple profiles and most of the standard HEC-2 options. The only options not available to the user, if the split flow option is used, are encroachment methods 3, 4, 5, and 6.

There are many types of split flows that occur in rivers. The following is a list of the more commonly encountered types of split flows.

- Split flows caused by islands or high ground.
- Split flows caused by levee overtopping.
- Split flows caused by watershed divide overtopping.
- Split flows caused by diversion structures.

The HEC-2 split flow option is capable of analyzing all of the above split flows, with the exception of the island or high ground type of split flows. Appendix III has been provided in this document to assist the user that has a split flow caused by islands or high ground. The solution procedure is the classic divided flow analysis technique.

Computation Procedure.

The computation procedure used to solve the problem of split flows is basically a one dimensional steady state method of trial and error, as follows:

1. The program computes the water surface profile and adjusts the discharges to reflect the assumed overflows. No overflows are assumed to occur for the first iteration unless the user has specified overflow values on JS cards.
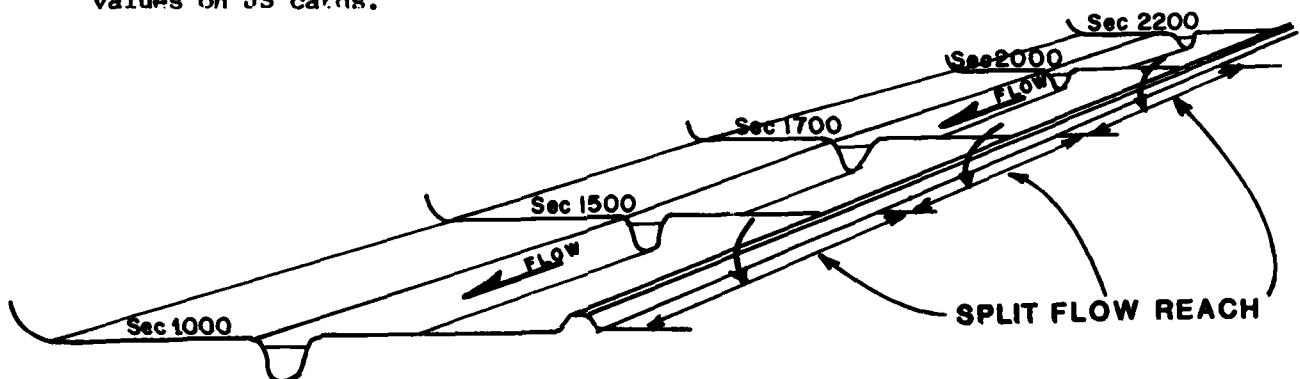
FIGURE 1

2. The location of each split flow reach (Figure 1) is defined in relation to the model by the upstream and downstream cross section numbers. Based on the cross secion numbers, the water surface or energy elevations are determined from the water surface profile performed in step one and are used to calculate the overflow.

3. The computed and assumed overflows for each split flow reach and their cumulative values are compared. If the difference between any of the values for computed and assumed is greater than 2 percent, the program makes a new assumption of overflows and repeats steps 1 through 3 until an acceptable tolerance is met or until the program has performed 20 iterations.

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Program Limitations.

The following assumptions are implicit in the analytical expressions used in the HEC-2 program and the split flow option:

1. Flow is steady because time dependent terms are not included.

2. Flow is gradually varied because a hydrostatic pressure distribution is assumed in the energy equation.

3. Flow is one-dimensional because the total energy head is the same for all points at a cross section location.

4. The river has a channel slope of no more than 10 percent.

5. The split flows can be estimated by the standard weir equation, the normal depth equation, or a rating curve of outflow -vs- elevation.

6. Submergence of the overflow weir by tailwater is insignificant.

7. The weir flow is linearly integrated along the length of the weir based on the upstream and downstream water surface or energy elevations.

8. The normal depth conveyance is linearly integrated along the length of the normal depth cross section based on the upstream and downstream water surface elevations.

9. The direction of the main stream flow is at right angle to the split flow.

10. Split flow is controlled by either the water surface elevation or the energy elevation.

11. Flow boundaries are fixed. This is to say that the cross section and weir geometries do not erode or change with time.

12. Split flows that are not returned to the system are removed from the entire model downstream from the split flow location. Because HEC-2 does not take into account the variation of flow with time, the user must be careful in using the HEC-2 split flow option in cases where the split flow at an upstream location does not have a constant effect on the peak discharges further downstream. An explanation of this problem and a solution strategy is given in the section titled Hydrologic Considerations.

HEC-2 SPLIT FLOW INPUT DESCRIPTION

The split flow input data must be entered as the first data of an HEC-2 run, with the exception of the ED card (EDIT2 program). The split flow input data must always start with an SF card and end with an EE card. The EE card must be followed by the regular HEC-2 input data cards.

The split flow input data uses the standard HEC input format, in which the first field contains a two character card identifier, and has six columns for data while the next nine fields contain each. The above format is for numeric data. The format for title card columns for card identifier and the remaining seventy eight columns for alpha-numeric information.

The split flow data input varies from the standard HEC-2 format in that a set of data cards is always preceded by a title card and the title card is required. The order in which the cards are entered must be followed exactly for each set or group of cards. The sets of cards need not be in any specific order, but it is recommended that split flow reaches be entered in a downstream direction to make the output more readable. A detailed description of the split flow data card input format is given in Appendix I. The following is a description of the general card types.

Split Flow Title Card.

The SF card is a title card used to activate the split flow option. It is a required card and must be the first input data card in the deck.

Job Card Set.

The job card set consists of the JC and JP cards. The job card set is optional and is used to control the processing of the split flow data. A job card set may be placed anywhere in the split flow input data. The JC card is the first card of the set and is used as a title card. The JP card is used to set the level of printout, allowed error tolerance, maximum number of iterations, use of either water surface or energy elevation, and percent of split flow to return.

Weir Reach Card Set.

The weir reach set is composed of three types of cards. The first card of the set is the TW card. The TW card is a title card and must be the first card of the set. The second card is the WS card, which contains information dealing with the number of points describing the weir, weirflow coefficient, location of the downstream and upstream limits of the weir in relation to section numbers and the section number where the flow returns. The third card of the set, the WC card, describes the weir geometry by the use of station and elevation coordinates. The coordinate points must start at the downstream end and proceed in an upstream direction.

Normal Depth Reach Card Set.

The normal depth reach set is composed of three types of cards. The first card of the set is the TN card, which is a title card and must be the first card of the set. The second card, the NS card, is similar to the WS card, with the exception that instead of having the weirflow coefficient, it has the energy slope and 'n' value. The third card, the NG card, is used to describe the normal depth cross section geometry by the use of station and elevation coordinates, with the coordinates starting at the downstream end.

Diversion Reach Card Set.

The diversion reach set is composed of three types of cards. The first card of the set is the TC card, which is a title card and must be the first card of the set. The second card, the CS card, contains information dealing with the number of points describing the diversion rating curve, loaction of the diversion in relation to section numbers, and the section number where the diverted flow returns. The third card, the CR card, is used to describe the rating curve by the use of discharge and elevation coordinates.

End Split Flow.

The EE card is required to terminate the split flow input data.

Additional HEC-2 Cards.

Several additional input data cards have been added to the standard HEC-2 input to facilitate the use of the split flow option. The new cards are the JR, JS, and RC cards.

The JR card is used to input a rating curve that is used to start the backwater. The JR card follows the J1 card and is read when the J1 card variable STRT is greater than one. The STRT value in this case is used to indicate the number of rating curve values that will be read on the JR card.

The RC card is used to input a rating curve at any cross section, which will be used instead of a calculated backwater answer. It operates in the same manner as an X5 card.

The JS card is used to specify the starting assumed split flow for each reach defined in the split flow data sets. The JS card follows the J1 or JR cards. It is an optional card and if omitted, the program assumes for its first trial that no flow is being lost.

GENERAL MODELING CONSIDERATIONS

The split flow option requires that the cross section numbers (X1 card) continually increase in value from downstream to upstream. It is recommended that station values in feet or miles measured along the main channel be used for cross section numbers. This is important because the HEC-2 program uses the cross section numbers specified on the split flow reaches to determine what water surface or energy grade line elevations to use in determining the amount of flow lost. Each split flow reach is located based on cross section numbers at the downstream and upstream ends of the reach. If the downstream and upstream split flow locations do not match a cross section number, the program will linearly interpolate between cross section numbers to determine the water surfaces or energy grade line elevations. A wise practice would be to start and end the split flow reaches at cross section numbers that appear in the HEC-2 hydraulic model.

Split Flow Reach Length Consideration.

The overflow reaches should be kept as short as possible. The longer the split flow reaches, the less accurate will be the split flows and backwater answers. The split flow problem can be compared to the integration of a curve by the Trapezoidal Rule, which is an approximate method of subdividing the curve into a number of straight line segments and calculating the areas under each straight line segment and then adding up the subareas to calculate the total area under the curve. The smaller the straight line segments and the larger the number of segments, the more accurate will be the calculated area. The same
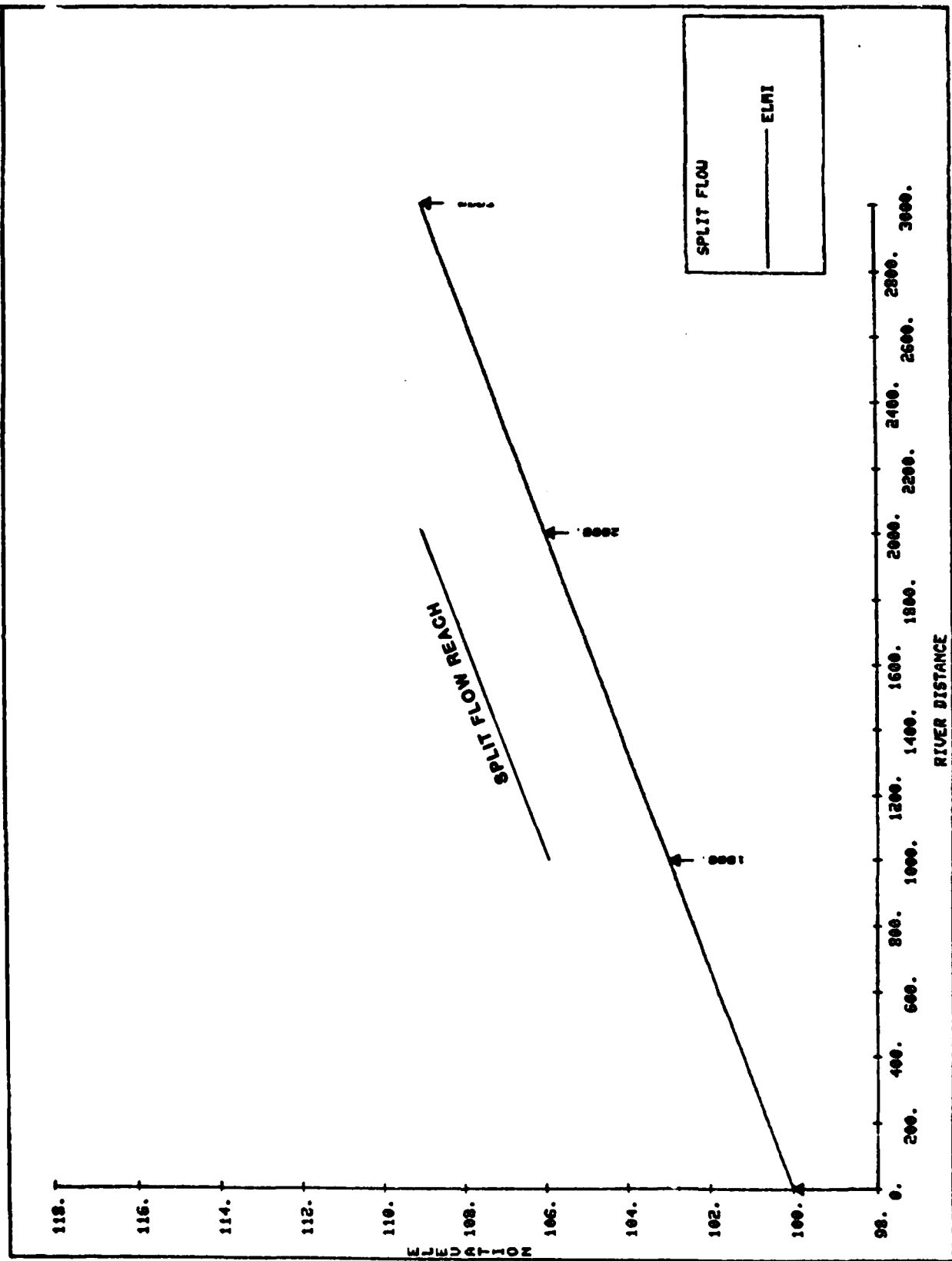
11

FIGURE 2

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logic applies to the calculation of the split flows. The shorter the split flow reaches and the additional cross sections defining them, the more accurate will be the calculated outflows and water surface elevations.

The effect of subdividing a split flow reach and addition of cross sections can be seen in the following example. Figure 2 shows a profile plot of a stream and a split flow reach which has a total reach length of 1000 feet. The split flow reach was modeled in four different ways. The first model represented the split flow reach as a single 1000 foot long reach. The second model divided the split flow reach into two 500 foot reaches. The third model divided the split flow reach into four 250 foot reaches and the fourth model divided it into ten 100 foot reaches. Note that each reach has a cross section defining it upstream and downstream. Additional cross sections must be used because the split flow discharges are calculated based on a linear interpolation of the upstream and downstream cross section water surface or energy elevations. The effect of dividing up the split flow reach into shorter and shorter segments, is to produce answers which are more accurate. The results from these four models are presented on Figure 3, which shows plots of the flow in the main river -vs- river distance. The results clearly show that the 1000 foot reach should be divided into shorter reaches. The fourth model produced the most accurate results, but it is also clear from the plotted results, that the second and third models gave acceptable results.

The example also shows that the upstream portion of a uniform split flow reach should be divided into shorter segments than the downstream portion, because a larger proportion of the flow will be lost on the upper portion.
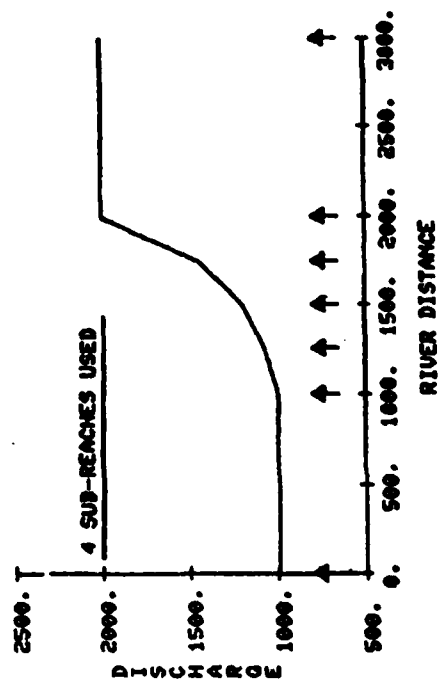
13

FIGURE 3

14
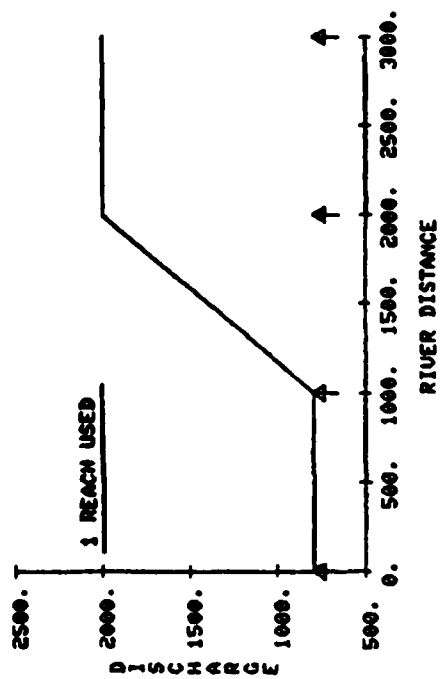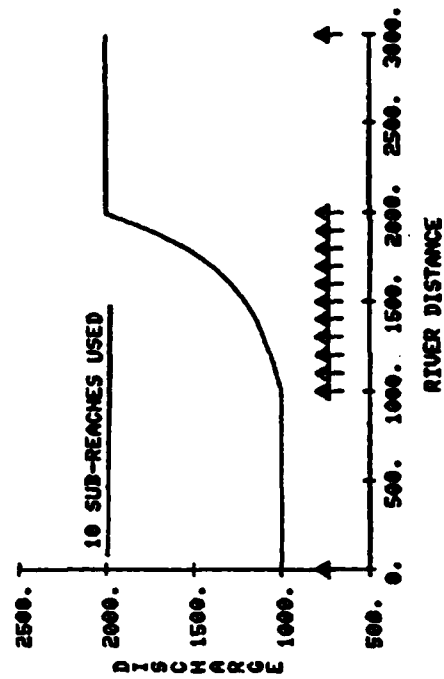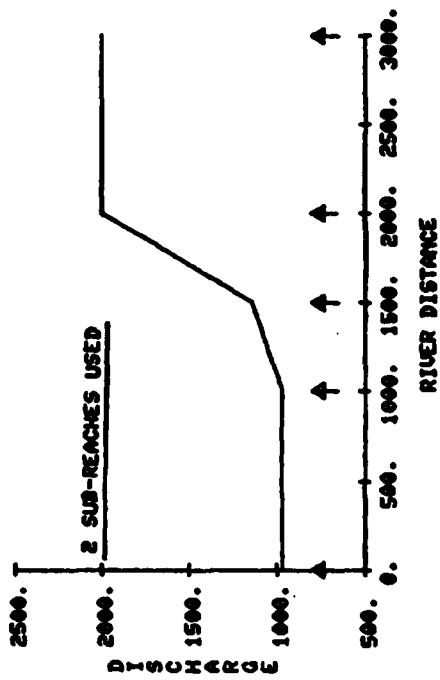
Hydrologic Considerations.

A common practice for hydraulic analysis is to use the flood hydrograph peak discharge values for the backwater calculations and ignore the fact that in most cases the peaks of the hydrographs do not occur at the same time. In many cases the effect of this assumption on the calculated water surface profile is well within the accuracy for profile calculations. Most HEC-2 models are assembled in this manner. When it comes to a split flow analysis, the effect of using the peak discharges as steady flow should not be ignored.

The HEC-2 split flow option, as a default, reduces all discharge values downstream from a split flow reach by the calculated split flow values. For example, if 1000 cfs is lost at the headwaters of a stream, the program will reduce all the discharges by 1000 cfs all the way downstream to the start of model or to the section number where the user has specified that it returns. The only way to determine the validity of reducing the discharges in this manner is to look at the entire hydrograph, to see how the loss from the split flow effects the peak discharges downstream. It may be that the peak discharge further downstream will only be partially effected by the split flow loss. The peak discharges downstream may be more dependent on the timing of tributary and local inflows.

To illustrate this problem, the following simple example is presented. As shown on Figure 4, the Upper Main Stem has a split fow reach just upstream from the confluence with Tributary No 1. Figure 5 is a plot of the original hydrographs for the Upper Main Stem, Tributary No 1, and their combined hydrographs on the Lower Main Stem. If flows that exceed 3000 cfs on the Upper Main Stem are lost, then the modified hydrographs plotted on Figure 6 occur.

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Comparing the original hydrographs with the modified shows the peak discharge on the Lower Main Stem reduced by 1000 cfs, peak flow on Tributary No 1 unaffected, and the peak discharge on the Lower Main Stem reduced by 500 cfs. The HEC-2 split flow option would have reduced the Lower Main Stem peak discharge by 1000 cfs and not by the correct amount of 500 cfs.

SPLIT FLOW REACH
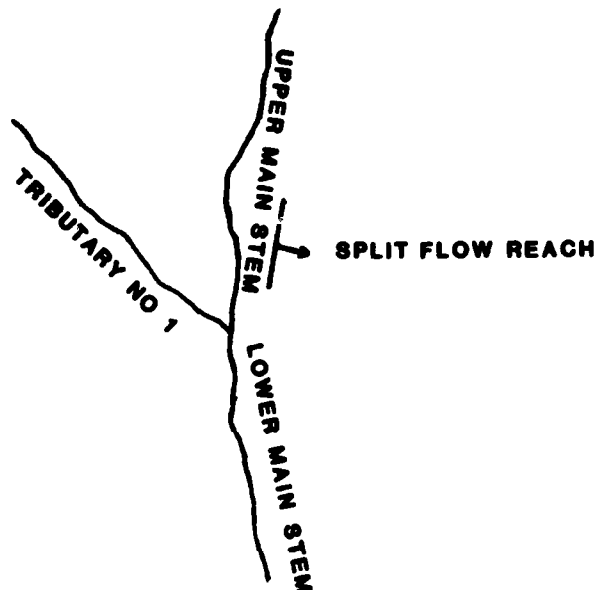
FIGURE 4

Consideration must also be given to the effect of storage routings. The effect of routing a flood wave is to reduce the peak discharge. Therefore a peak discharge further downstream based on routing will not be reduced by the total amount that was lost upstream.

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FLOOD HYDROGRAPHS
SPLIT FLOW PROBLEM
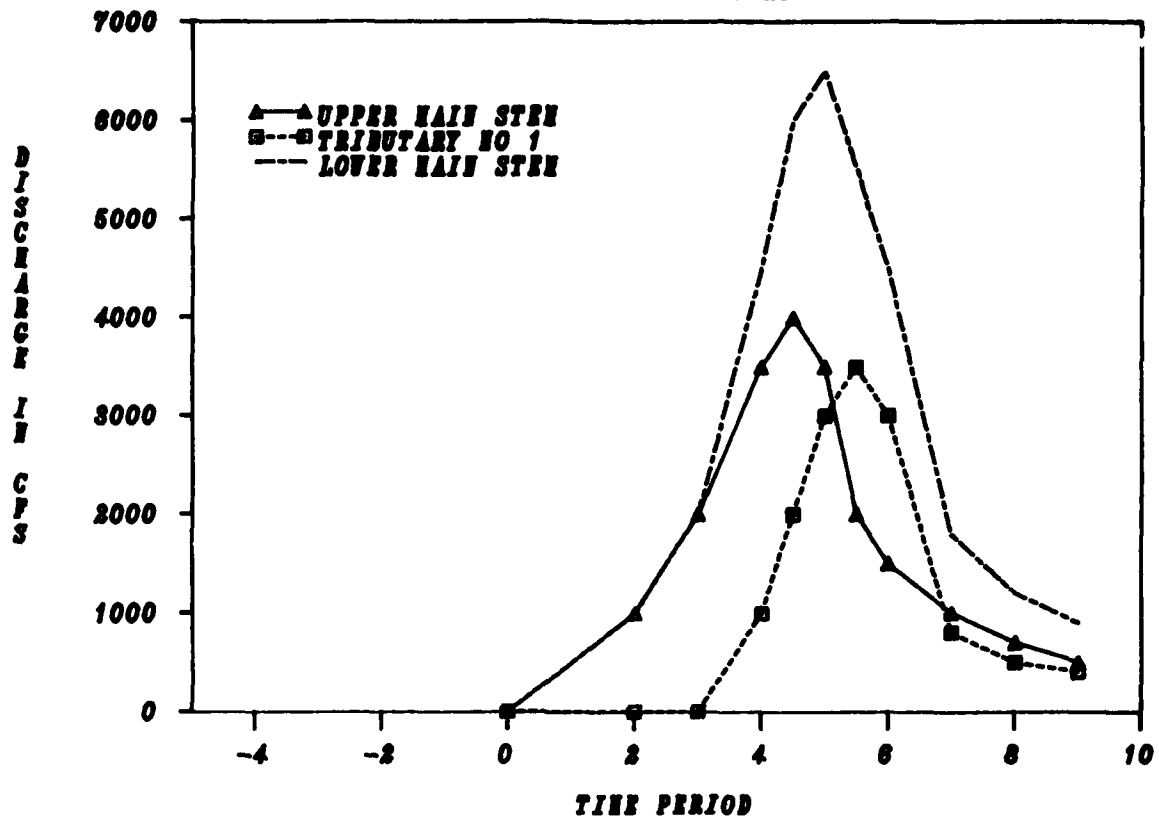
FIGURE 5

FLOOD HYDROGRAPHS
SPLIT FLOW PROBLEM

FIGURE 6

17
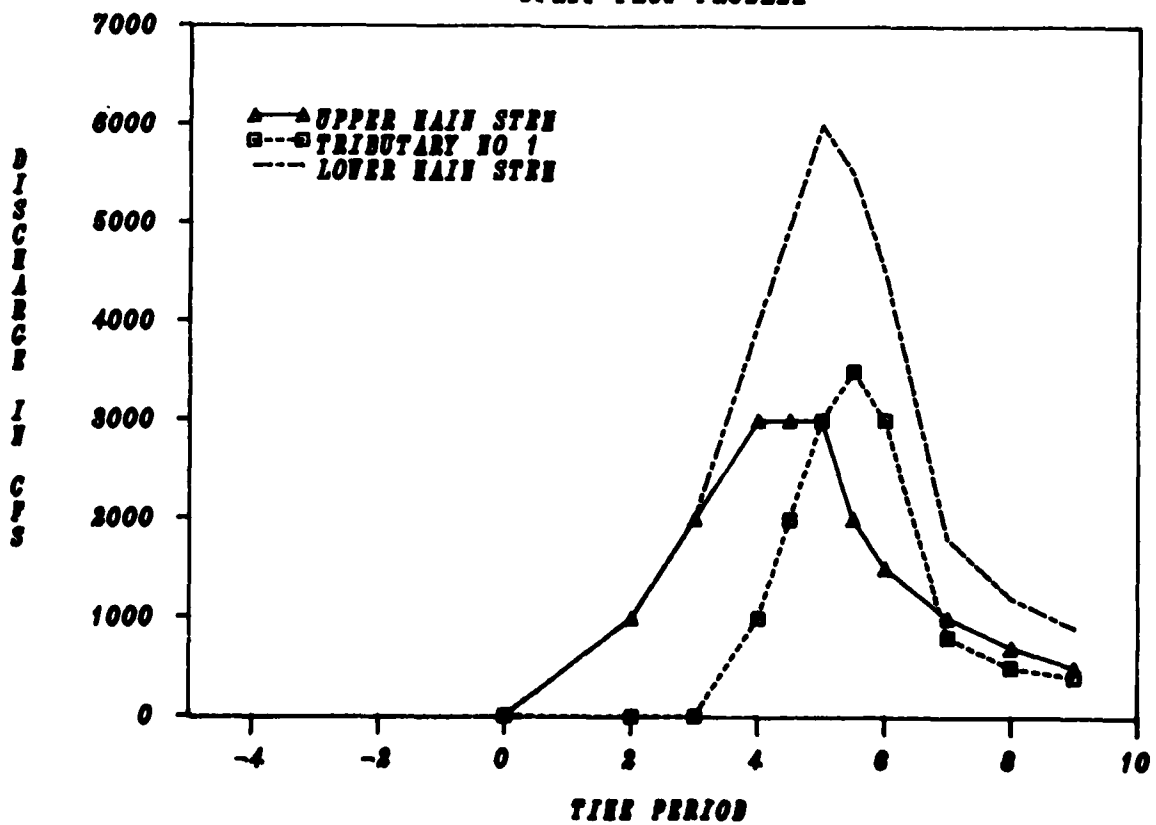
The following procedure can be used to account for the hydrologic aspects of a split flow problem.

1. Make an initial HEC-2 run which reduces the split flows all the way downstream.

2. Alter the hydrologic model (HEC-1), at the split flow reach, to reflect the lost flow and execute it again. Analyze the effect that the split flows had on the peak discharges downstream from the split flow reach.

3. If the assumption of reducing the lost flow is valid, then no further analysis are needed. If the lost flow is only partially effective downstream, then the lost flows should be returned further downstream. This can be accomplished by modifying the HEC-2 discharge cards to reflect the expected reductions downstream from the split flow reach and returning the split flows back into the model.

4. An HEC-2 run should be made and steps 2 and 3 repeated until an acceptable solution is achieved.

This procedure is applicable for simple split flow problems which do not have more than three or four separate split flow reaches. For the more complicated split flow problem, an unsteady state program should be used. The DWOPER (Dynamic Wave Operational Model) program developed by the National Weather Service (reference 8) is a one dimension unsteady state program that can be used to solve the split flow problem.

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APPENDIX I

SPLIT FLOW INPUT AND OUTPUT DATA DESCRIPTION

SLIT FLOW TITLE CARD

CARD SF - SPLIT FLOW CARD (REQUIRED IF SPLIT FLOW OPTION IS TO BE USED)

The SF card is used to flag the split flow option. Only one SF card can be used. The SF card has to be the first card in an HEC-2 deck.

Field	Variable	Value	Description
0	IA	SF	Card identification characters.
1-10			Alpha-numeric Title data.

CARD JC - TITLE JOB CARD FOR SPLIT FLOW (OPTIONAL)

The JC card is used to indicate that JP card follows. The JP card must follow the JC card.

Field	Variable	Value	Description
0	IA	JC	Card identification characters.
1-10			Alpha-numeric Title data.

CARD JP - JOB PARAMETER CARD

The JP card is used to set several job parameters dealing with the
split flow computations. The JC and JP cards are optional and can be
placed anywhere in the split flow data or completely left out. They
should be placed normally after the SF cards.

Field	Variable	Value	Description
0	IA	JP	Card identification characters.
1	ISFTR	0	Printout control of split flow computations will be held to a minimum.
		1	Trace each split flow iteration.
		10	Trace both the split flow and backwater iterations.
2	AEROR	0	The program will use a value of 2 percent allowed error for convergence.
		+	The user may specify the allowed percent tolerance for convergence.
3	NAITER	0	The maximum number of iterations for split flow to be executed per profile (20 is the default value).
		+	The user may specify the maximum number of iterations.
4	IUEG	-1,0	The program will use the water surface to determine the overflow.
		1	The program will use the energy grade line to determine the overflow.
5	PERFR	0	One hundred percent of the overflow is to be returned at SNOFR (WS.4, NS.4, and CS.4).
		+	Percent of overflow to be returned at SNOFR (WS.4, NS.4, and CS.4).

CARD TW - TITLE CARD FOR WEIR LOCATION

The TW card is required for each set of weir outflow data set. The
TW card must be followed by a set of WS and WC cards.

Field	Variable	Value	Description
0	IA	TW	Card identification characters.
1-10			Alpha-numeric Title data.

CARD WS - WEIR PARAMETER DATA CARD

The WS card is required for each TW card used and must follow it.
The WS card contains information dealing with the number of points
describing the weir, weir flow coefficient, location of the upstream
and downstream limits of the weir in relation to section numbers as
used in the X1 cards, and the section number where the flow returns.
If the flow does not return, a value of -1 should be used. It is
required that the section numbers used to set-up the backwater
model increase from downstream to upstream. The same rule applies
for supercritical models.

Field	Variable	Value	Description
0	IA	WS	Card identification characters.
1	NWPL	+	Number of coordinate points that describe the weir on the WC card.
2	DSSNO	0,+	Downstream section number where the first weir coordinate applies.
3	USSNO	0,+	Upstream section number where the last weir coordinate applies.
4	SNOFR	0,+	Section number where the lost weir flow returns.
		-1	The weir flow does not return.
5	COEFL	+	Coefficient of discharge for use in weir flow equation.
6-10			Not used.

CARD WC - THE WEIR COORDINATE CARD

The WC card is used to input the weir coordinates. The weir coordinates must start at the downstream end and proceed upstream. The maximum number of coordinates is 100.

Field	Variable	Value	Description
0	IA	WC	Card identification characters.
1,3,5, 7,9	STA(I)	+	Station Value of weir coordinate.
2,4,6, 8,10	ELO(I)	+	Elevation value of weir coordinate.

CARD TN - TITLE CARD FOR NORMAL DEPTH LOCATION

The TN card is required for each set of normal depth outflow data set.
The TN card must be followed by a set of NS and NG cards.

Field	Variable	Value	Description
0	IA	TN	Card identification characters.
1-10			Alpha-numeric Title data.

CARD NS - NORMAL DEPTH PARAMETER DATA CARD

The NS card is similar to the WS card with the exception that instead of
having the weir flow coefficient, it has the energy slope and 'n' value.

Field	Variable	Value	Description
0	IA	NS	Card identification characters.
1	NWPL	+	Number of coordinate points that describe the normal depth flow cross section on the NG card
2	DSSNO	0,+	Downstream section number where the first coordinate point on the NG card applies.
3	USSNO	0,+	Upstream section number where the last coordinate point on the NG card applies.
4	SNOFR	0,+	Section number where the lost flow returns.
		-1	The lost flow does not return.
5	XNVND	+	The 'n' value to be used for normal depth calculation.
6	SLOPND	+	The energy slope to be used for normal depth calculations.
7-10			Not used.

CARD NG – THE GROUND COORDINATE CARD

The NG card is used to input the normal depth cross section coordinates.
The coordinate must start at the downstream end and proceed upstream.
The maximum number of coordinates is 100.

Field	Variable	Value	Description
0	IA	NG	Card identification characters.
1,3,5, 7,9	STA(I)	+	Station Value of cross section.
2,4,6, 8,10	ELO(I)	+	Elevation value of cross section.

CARD TC - TITLE CARD FOR RATING CURVE LOCATION

The TC card is required for each set of rating curve outflow data
set. The TN card must be followed by a set of CS and CR cards.

Field	Variable	Value	Description
0	IA	TC	Card identification characters.
1-10			Alpha-numeric Title data.

CARD CS - RATING CURVE PARAMETER DATA CARD

The CS card is similar to the WS card with the exception that the
location (upstream and downstream) is a point location and therefore
the value entered for USSNO and DSSNO should normally be equal.

Field	Variable	Value	Description
0	IA	CS	Card identification characters.
1	NWPL	+	Number of discharge elevation pairs to be read from the CR cards to follow.
2	DSSNO	0,+	Downstream section number where the rating curve applies.
3	USSNO	0,+	Upstream section number where the rating curve applies.
4	SNOFR	0,+	Section number where the lost flow returns.
		-1	The lost flow does not return.
5-10			Not used.

CARD CR - RATING CURVE CARD

The CR card is used to input the rating curve of outflows. The location of the rating curve has to be at a specific location on the river. Therefore the location has to be specified at only one point. The variables DSSNO and USSNO should be set equal. If they are not, the program will use the mean of the two locations. The maximum number of rating curve points is 100.

Field	Variable	Value	Description
0	IA	CR	Card identification characters.
1,3,5, 7,9	STA(I)	+	Discharge values for rating curve.
2,4,6, 8,10	ELO(I)	+	Elevation values for rating curve.

CARD EE - END OF SPLIT FLOW DATA CARD

The EE card is required to terminate the reading of the split flow data. The EE card should be in front of the first regular HEC-2 card, such as the AC, C, or T1 cards.

Field	Variable	Value	Description
0	IA	EE	Card identification characters.
1-10			Not used.

MODIFICATION TO J1 CARD

The J1 card variable STRT (Field 5) has been altered so that the program
will accept a rating curve as a starting backwater condition. The option
is activated by entering in field five (STRT variable) of the J1 card the
number of discharge elevation rating curve points. The rating curve is
entered after the J1 card using JR cards.

CARD JR - STARTING RATING CURVE CARD

The JR cards are used to input a starting rating curve. A set can be
placed for each profile being run. They must follow the J1 card and
the number of rating curve points must be greater than two. It is
required that the number of rating curve points be entered on the J1
card, field five. A maximum of twenty discharge elevation values
is allowed. The program linearly interpolates between given rating
curve values and extrapolates for values outside the rating curve.

Field	Variable	Value	Description
0	IA	JR	Card identification characters.
1,3,5, 7,9	QJ1(I)	+	Discharge values.
2,4,6, 8,10	XJ1(I)	-,0,+	Water surface elevation values.

JS - CARD STARTING SPLIT FLOW ASSUMPTION CARD

The JS card is used to specify the starting assumed lost discharges
for each reach defined in the split flow data set. If the JS card
is not entered for a profile, then the program assumes that the first
trial assumed lost flow is zero for all the split flow reaches. The
JS card should follow the J1 card or the JR card if used. A maximum
of 100 values are allowed.

Field	Variable	Value	Description
0	IA	JS	Card identification characters.
1	N	+	Number of assumed lost discharges to read.
2	ARLO(4,1)	+	Assumed lost discharge for first reach.
3	ARLO(4,2)	+	Assumed lost discharge for second reach.
.	.	.	.
.	.	.	.
.	.	.	.
	ARLO(4,N)	+	Assumed lost discharge for last reach.

Continue on in field one of additional JS cards up to ARLO(4,N).

CARD RC - RATING CURVE CARD

The RC card can be entered at any cross section and the program will
determine the water surface elevation based on the rating curve and
not on backwater computations. The RC card should be placed after the
X1 card. A maximum of twenty discharge elevation values are allowed.
The program linearly interpolates between given rating curve values
and extrapolates for values outside the rating curve.

Field	Variable	Value	Description
0	IA	RC	Card identification characters.
1	NRCP	+	Number of rating curve points being read in.
2	ORC(1)	+	Discharge value.
3	XRC(1)	-,0,+	Water surface elevation value.
4	ORC(2)	+	Discharge value.
5	XRC(2)	-,0,+	Water surface elevation value.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
	ORC(NRCP)	+	Last discharge value.
	XRC(NRCP)	-,0,+	Last water surface elevation value.

Continue on in field one of additional RC cards up to ORC(NRCP) and
XRC(NRCP).

HEC-2 SPLIT FLOW OPTION OUTPUT VARIABLES

Variable   Description

ASQ   The assumed split flow value used by the program to compute the
                   water surface elevations.

O COMP   The computed split flow value based on the computed water surface
                   elevation.

ERRAC   The percent error between the assumed discharge and computed
                   discharge.

TASQ   The total assumed split flow for the entire HEC-2 model.

TCO   The total computed split flow for the entire HEC-2 model.

TABER   Percent of error between the total assumed split flow and total
                   computed split flow.

NITER   The number of iterations that the program has executed in computing
                   the answer.

DSWS   The computed downstream water surface elevation.

USWS   The computed upstream water surface elevation.

DSSNO   The downstream section number where the split flow reach begins.

USSNO   The upstream section number where the split flow reach ends.

TOTAL AREA   The total cross sectional area for a normal depth overflow
                   reach.

AVG VELOCITY   The average velocity of the normal depth overflow reach.

MAX DEPTH   The maximum depth that occurs on the normal depth overflow
                   section.

AV DEPTH   The average depth of flow for the normal depth section based
                   on the total area divided by the water surface topwidth.

TOP WIDTH   The width of the normal depth overflow section.

TOP WIDTH   The width of the overflow section based on the computed
                   water surface.

I-14

APPENDIX II

SPLIT FLOW EXAMPLE PROBLEM

EXAMPLE OF INPUT PREPERATION

The following problem is provided to illustrate the input preparation required when using the split flow option. The input is shown on Figure 9 and is described below. A complete HEC-2 computer output listing for this example is also provided.

A plan view of the levee system and floodway of the Red Fox River is shown in Figure 7. A profile view of the stream bed, levees and overflow weir are shown in Figure 8. As can be seen on the profile view, the right bank or south levee is the critical levee for a split flow analysis. This is because it has the overflow weir and is several feet lower than the north levee.

The starting water surface for this example will be based on a normal depth calculation using a slope of .005 ft/ft. The weir coefficient for the levee will be 3.4 and for the overflow weir, 2.7. The weir coefficient for the overflow weir is low to account for the submergence caused by the tailwater in the floodway.

The first card of the split flow input data is the SF card. The split flow reach in this example is divided into three shorter reaches. The first split flow reach to be modeled is the most upstream reach which lies between sections 3 and 4. The TW card follows the SF card and is used to identify the reach. The WS card follows the TW card and is used to specify the number of coordinates that describe the levees geometry, location of the downstream and upstream limits and the section number where the split flow returns. The split flow does not return and a value of -1 is used to so indicate. Station and elevation coordinate data is entered on the WC card to describe the weir geometry. The

coordinate data start at section 3 and proceed upstream to section 4.

The same procedure used for the first upstream reach is used for the overflow weir reach, which lies between sections 2 and 3, and for the downstream levee reach which lies between section 1 and 2.

In this example problem it was assumed that the weir equation was the more appropriate to use for calculating the split flows. If a normal depth or diversion assumption had been preferred, then the only difference in input would have been that the normal depth or diversion split flow cards would have been used.
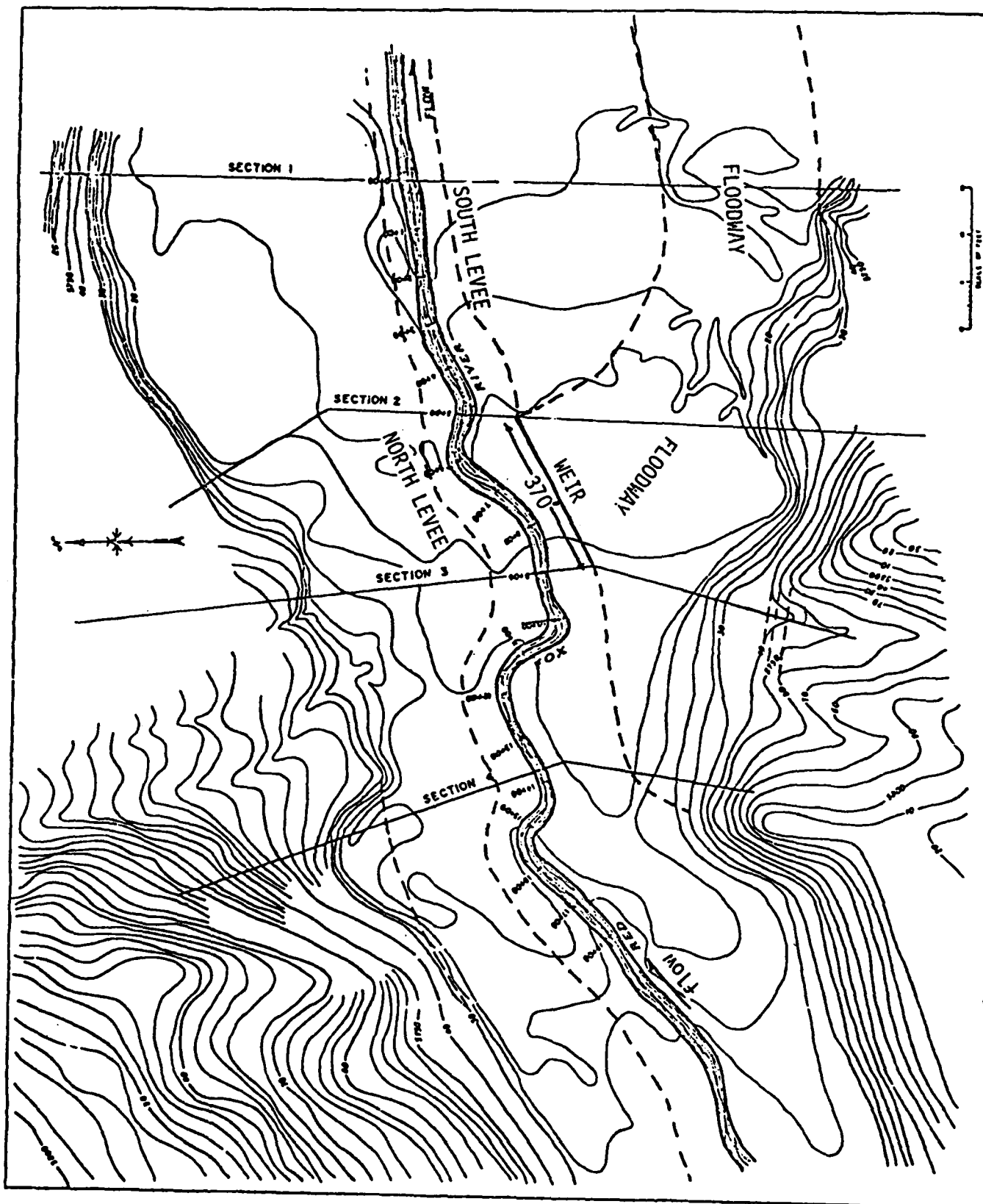
FIGURE 7 Plan view of the Red Fox River, Colorado

II-3
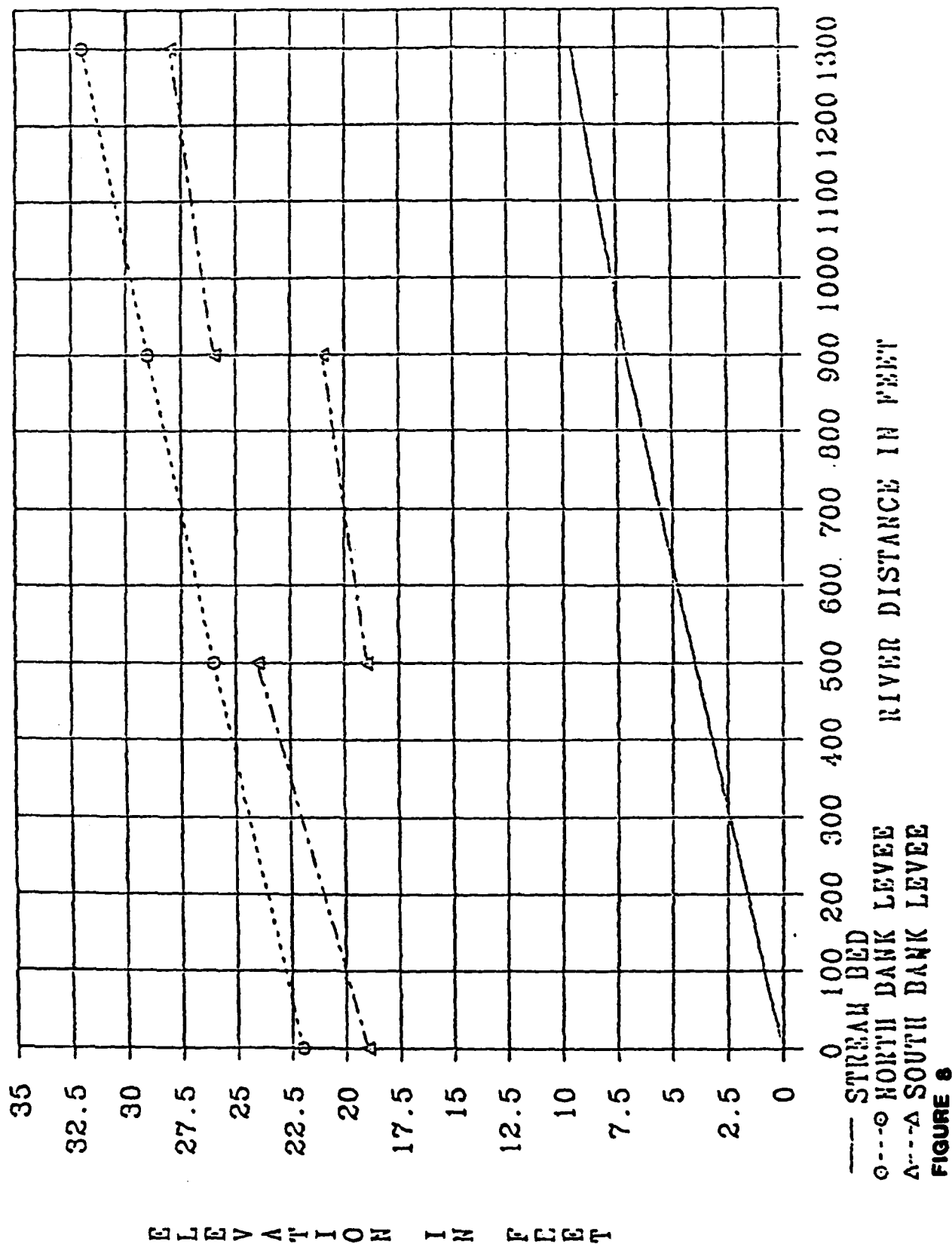
PROFILE PLOT OF RED FOX RIVER
SPLIT FLOW PROBLEM

FIGURE 8

II-4

GENERAL PURPOSE DATA FORM
(8 COLUMN FIELDS)

PROGRAM: HEC-2
REVIEWED BY: AL MONTALVO
PREPARED BY:
CHECKED BY:
DATE:
PAGE:

	1	2	3	4	5	6	7	8	9	10
SF	SPLIT FLOW PROBLEM									
TW	RIGHT BANK LEVEE BETWEEN SECTIONS 3 AND 4									
WS	2.	3.	4.	-1.	3.4					
WC	26.	460.	28.							
TW	RIGHT BANK FLOODWAY OVER-FLOW WEIR									
WS	2.	3.	-1.	2.7						
WC	19.	370.	21.							
TW	RIGHT BANK LEVEE BETWEEN SECTIONS 1 AND 2									
WS	2.	3.	-1.	3.4						
WC	19.	520.	24.							
EE										
T1	SPLIT FLOW WORKSHOP SOLUTION									
T2	ADVANCED HEC-2 WORKSHOP									
T3	RED FOX RIVER									
T1	2.			.005				3.8		
CI	3.	7000.	24000.	40000.						
WC	.1	.3								
NH	5.	.1	.05	415.	.05	650.	.03	740.	.05	1020.
WH	16.35									

SPK FORM 321a
29 JUN 70
FIGURE 8

```
**********************************************
HEC2 RELEASE DATED NOV 76 UPDATED MARC 1982
ERROR CORR - 01,02,03,04,05
MODIFICATION - 50,51,52,53,54,55
**********************************************
```

SPLIT FLOW BEING PERFORMED

SF   SPLIT FLOW PROBLEM

RIGHT BANK LEVEE BETWEEN SECTIONS 3 AND 4

```
TW   2    3    4
          -1   3.4
WS        26   460   28
WC
```

RIGHT BANK FLOODWAY OVER-FLOW WEIR

```
TW   2    2    3
          -1   2.7
WS        19   370   21
WC
```

RIGHT BANK LEVEE BETWEEN SECTIONS 1 AND 2

```
TW   2    1    2
          -1   3.4
WS        19   520   24
WC
```

T1   SPLIT FLOW WORKSHOP SOLUTION
T2   ADVANCED HEC2 WORKSHOP
T3   RED FOX RIVER

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	2.	0.	0.	.005000	0.	0.	0.	3.800	0.
QT	3.000	7000.000	24000.000	40000.000						
NC	0.	0.	0.	.100		-0.300	-0.	-0.	-0.	-0.
NH	5.000	.100	415.000	.050		650.000	0.	0.	0.	0.
NH	1635.000	0.	415.000	0.		0.	.030	710.000	1020.000	.100
X1	1.000	11.000	650.000	710.000		0.	0.	0.	0.	0.
X3	-0.	-20.000	-0.	622.000		-0.	752.000	-0.	-0.	-0.
GR	25.000	20.000	18.000	110.000		17.000	415.000	14.000	1.000	675.000
GR	25.000	690.000	1.000	710.000		13.000	710.000	14.000	14.000	1590.000
NH	4.000	1635.000	415.000	.050		575.000	.030	640.000	1250.000	0.
X1	2.000	10.000	575.000	640.000		500.000	500.000	500.000	0.	0.
X3	-0.	-0.	-0.	525.000		-0.	735.000	-0.	-0.	-0.
GR	25.000	30.000	20.000	110.000		20.000	200.000	17.000	10.000	575.000
GR	4.000	580.000	4.000	615.000		18.000	640.000	18.000	25.000	1250.000
NC	.100	.050	.030	0.		0.	0.	0.	0.	0.
X1	3.000	10.000	390.000	600.000		400.000	400.000	400.000	0.	0.
X3	-0.	-0.	-0.	390.000		-0.	600.000	-0.	-0.	-0.
X4	1.000	17.200	390.000	-0.		18.700	370.000	15.000	7.100	500.000
GR	25.000	40.000	22.000	260.000		20.000	600.000	22.000	25.000	875.000
NH	7.500	530.000	17.300	560.000		330.000	.036	460.000	610.000	.100
NH	700.000	.100	130.000	0.		0.	0.	0.	0.	0.
X1	4.000	8.000	330.000	460.000		400.000	400.000	400.000	0.	0.
X3	-0.	-0.	-0.	300.000		-0.	600.000	-0.	-0.	-0.
GR	26.000	30.000	24.000	130.000		23.000	330.000	9.500	10.000	400.000
GR	22.000	460.000	22.000	610.000		26.000	700.000	0.	0.	0.
EJ	-0.	-0.	-0.	-0.		-0.	-0.	-0.	-0.	-0.

```
SECNO    DEPTH   CWSEL   CRIWS   WSELK   EG      HV      HL      OLOSS      BANK ELEV
Q        QLOB    QCH     QROB    ALOB    ACH     AROB    VOL     TWA        LEFT/RIGHT
TIME     VLOB    VCH     VROB    XNL     XNCH    XNR     WTN     ELMIN      SSTA
SLOPE    XLOBL   XLCH    XLOBR   ITRIAL  IDC     ICONT   CORAR   TOPWID     ENDST
```

*PROF 1

CCHV= .100 CEHV=   .300
1490 NH CARD USED
*SECNO 1.000

```
3470 ENCROACHMENT STATIONS=   1.00   12.10
1.00      12.10   12.10   622.0   752.0   TYPE=       1  TARGET=             130.000    14.00
7000.     0.      7000.   0.      3.80    14.87       2.76        0.     0.     0.      13.00
0.        0.      13.34   0.      .050    525.        0.          0.     0.     0.      653.64
.004965   0.      0.      0.      0       .030        .050        6             56.36   710.00
```

1490 NH CARD USED
*SECNO 2.000

3301 HV CHANGED MORE THAN HVINS

```
3470 ENCROACHMENT STATIONS=   2.00   11.11
2.00      11.11   15.11   525.0   735.0   TYPE=       1  TARGET=             210.000    10.00
7000.     823.    6177.   0.      0.      16.94       1.83        1.97   7.    .09     18.00
.01       4.10    11.45   0.      201.    540.        0.          .000   0.    4.00    525.84
.003213   500.    500.    500.    .050    .030        .050        0             109.84  634.84
                                          3
```

*SECNO 3.000

3301 HV CHANGED MORE THAN HVINS

```
3470 ENCROACHMENT STATIONS=   3.00   10.16
3.00      10.16   17.26   390.0   600.0   TYPE=       1  TARGET=             210.000    17.20
7000.     0.      7000.   0.      0.      18.05       .80         1.02   15.   .10     100000.00
.03       0.      7.16    0.      .100    978.        0.          .013   0.    7.10    390.00
.002060   400.    400.    400.    2       .030        .050        0             169.90  559.90
```

1490 NH CARD USED
*SECNO 4.000

3301 HV CHANGED MORE THAN HVINS

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	LEFT/RIGHT
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	SSTA ENDST

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=   TYPE= 1 TARGET= 300.000

4.00	8.59	18.09	300.0	600.0	20.87	2.78	1.62		23.00
7000.	0.	7000.	18.09	0.	523.	0.	22.	.59	22.00
.04	0.	13.38	0.	.100	.036	.050	.018	3.	344.55
.011277	400.	400.	400.	20	15	0	0.	9.50	440.45
								95.91	

TW   RIGHT BANK LEVEE BETWEEN SECTIONS 3 AND 4

| ASQ | QCOMP | ERRAC | TASQ | TCQ | TABER | NITER | DSWS | USWS | DSSNO | USSNO |
| 0. | 0. | 0. | 0. | 0. | 0. | 2 | 17.259 | 18.091 | 3.000 | 4.000 |

TW   RIGHT BANK FLOODWAY OVER-FLOW WEIR

| ASQ | QCOMP | ERRAC | TASQ | TCQ | TABER | NITER | DSWS | USWS | DSSNO | USSNO |
| 0. | 0. | 0. | 0. | 0. | 0. | 2 | 15.109 | 17.259 | 2.000 | 3.000 |

TW   RIGHT BANK LEVEE BETWEEN SECIONS 1 AND 2

| ASQ | QCOMP | ERRAC | TASQ | TCQ | TABER | NITER | DSWS | USWS | DSSNO | USSNO |
| 0. | 0. | 0. | 0. | 0. | 0. | 2 | 12.105 | 15.109 | 1.000 | 2.000 |

```
*************************************************
HEC2 RELEASE DATED NOV 76 UPDATED MARC 1982
ERROR CORR - 01,02,03,04,05
MODIFICATION - 50,51,52,53,54,55
*************************************************
```

T1   SPLIT FLOW WORKSHOP SOLUTION
T2   ADVANCED HEC2 WORKSHOP
T3   RED FOX RIVER

	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
J1	0.	3.	0.	0.	.005000	0.	0.	0.	11.000	0.

	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
J2	2.000	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

28 MAY 81   13.16.47

```
SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       OLOSS    BANK ELEV
Q        QLOB     QCH      QROB     ALOB     ACH      AROB     TWA      LEFT/RIGHT
TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      ELMIN    SSTA
SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    TOPWID   ENDST
```

*PROF 2

CCHV= .100 CEHV=   .300
1490 NH CARD USED
*SECNO 1.000

```
3470 ENCROACHMENT STATIONS=       1  TARGET=          TYPE= 1
      1.00   18.30   18.30   622.0   752.0  22.98   4.68  130.000   14.00
   18134.    571.  16274.   1289.    115.   893.    220.     0.      13.00
      0.      4.95   18.22    5.86    .050   .030    .050     0.     622.00
   .004996    0.      0.      0.        0     14       0   130.00   752.00
```

1490 NH CARD USED
*SECNO 2.000

3301 HV CHANGED MORE THAN HVINS

```
3470 ENCROACHMENT STATIONS=       1  TARGET=          TYPE= 1
      2.00   18.50   22.50   525.0   735.0  24.81   2.31  210.000   10.00
   18134.   3557.  13789.    788.    570.  1012.    427.     .24     18.00
       .01    6.24   13.62    1.84    .050   .030    .100    2.     525.00
   .002206  500.    500.    500.        2      0       0     4.00   735.00
                                                                  210.00
```

*SECNO 3.000

3301 HV CHANGED MORE THAN HVINS

```
3470 ENCROACHMENT STATIONS=       1  TARGET=          TYPE= 1
      3.00   16.95   24.05   390.0   600.0  25.67   1.62  210.000   17.20
   24000.      0.  24000.      0.      0.  2346.     39.     .07  100000.00
       .02      0.   10.23     0.     .100   .030    .050    4.     390.00
   .001850  400.    400.    400.        3      0       0     7.10   600.00
                                                                  210.00
```

1490 NH CARD USED
*SECNO 4.000

3301 HV CHANGED MORE THAN HVINS

II-11

```
SECNO   DEPTH   CNSEL   CRIWS   WSELK   EG     HV    HL     OLOSS   BANK ELEV
Q       QLOB    QCH     QROB    ALOB    ACH    AROB  VOL    TWA     LEFT/RIGHT
TIME    VLOB    VCH     VROB    XNL     XNCH   XNR   WTN    ELMIN   SSTA
SLOPE   XLOBL   XLCH    XLOBR   ITRIAL  IDC    ICONT CORAR  TOPWID  ENDST
```

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS= 1   TARGET= 300.000   TYPE= 1

```
     4.00   15.69    25.19   300.0   600.0   28.64   3.45   1.25   .55    23.00
  24000.    238.   21492.   2270.      0.            446.   58.    6.     22.00
            3.76    15.67    5.09      63.   1372.    .050   .018   9.50  300.00
 .006443   400.     400.     400.      20     15      0      0.    300.00 600.00
```

*)   RIGHT BANK LEVEE BETWEEN SECTIONS 3 AND 4

ASQ	QCOMP	ERRAC	ASO	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
0.	0.	0.	0.	0.	0.	0.	9	24.048	25.186	3.000	4.000

TW   RIGHT BANK FLOODWAY OVER-FLOW WEIR

ASO	QCOMP	ERRAC	ASO	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
5866.49	5916.25	.84	5866.49	5866.49	5916.25	.84	9	22.496	24.048	2.000	3.000

TW   RIGHT BANK LEVEE BETWEEN SECIONS 1 AND 2

ASO	QCOMP	ERRAC	ASO	TASQ	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
0.	0.	0.	0.	5866.49	5916.25	.84	9	18.302	22.496	1.000	2.000

THIS RUN EXECUTED 28 MAY 81   13.16.48

```
*********************************************
HEC2 RELEASE DATED NOV 76 UPDATED MARC 1982
ERROR CORR - 01,02,03,04,05
MODIFICATION - 50,51,52,53,54,55
*********************************************
```

T1   SPLIT FLOW WORKSHOP SOLUTION
T2   ADVANCED HEC2 WORKSHOP
T3   RED FOX RIVER

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	4.	0.	0.	.005000	0.	0.	0.	20.000	0.

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15.000	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

```
28 MAY 81   13.16.47

SECNO   DEPTH   CWSEL   CRIWS   WSELK   EG     HV     OLOSS    BANK ELEV
Q       QLOB    QCH     QROB    ALOB    ACH    AROB   TWA      LEFT/RIGHT
TIME    VLOB    VCH     VROB    XNL     XNCH   XNR    ELMIN    SSTA
SLOPE   XLOBL   XLCH    XLOBR   ITRIAL  IDC    ICONT  TOPWID   ENDST
```

*PROF 3

```
CCHV=    .100 CEHV=   .300
1490 NH CARD USED
*SECNO 1.000

3470 ENCROACHMENT STATIONS=           752.0   TYPE=  1 TARGET=    130.000
  1.00   20.69   20.69   622.0   752.0  26.21  5.52            0.   0.
24415.   1168.  20908.   2338.   20.00  1036.  320.            0.   14.00
    0.    6.41   20.18    7.31    182.   .030  .050            0.   13.00
.005024     0.      0.      0.     .050     3     0.        130.00   622.00
                                                                     752.00

1490 NH CARD USED
*SECNO 2.000

3301 HV CHANGED MORE THAN HVINS

3470 ENCROACHMENT STATIONS=           735.0   TYPE=  1 TARGET=    210.000
  2.00   20.74   24.74   525.0   735.0  28.26  3.51    .20
25632.   5355.  19735.   1742.      0.  1158.  640.     2.   10.00
   .01    7.85   17.04    2.72    682.   .030  .100   4.00   18.00
.002885    500.    500.    500.     .050     2     0.        210.00   525.00
                                                                     735.00

*SECNO 3.000
3280 CROSS SECTION        1.35 FEET   3.00 EXTENDED

3470 ENCROACHMENT STATIONS=           600.0   TYPE=  1 TARGET=    210.000
  3.00   19.25   26.35   390.0   600.0  29.43  3.08    .04
39874.      0.  39874.      0.      0.  2830.    0.    47.   17.20
   .02      0.   14.09    400.      0.   .030  .050   7.10 100000.00
.002808    400.    400.            .100     3     0.        210.00   390.00
                                                                     600.00

1490 NH CARD USED
*SECNO 4.000
3280 CROSS SECTION        1.98 FEET   4.00 EXTENDED
```

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

3470 ENCROACHMENT STATIONS=   1   TARGET=   TYPE=

4.00	18.48	27.98	300.0	600.0	32.58	4.60	1.66	300.000	23.00
40000.	939.	32515.	0.	147.	1735.	837.	73.	.46	22.00
.02	6.38	18.74	.050	.050	.036	.050	.018	6.	300.00
.006738	400.	400.	400.	20	11	0	0.	9.50	600.00
								300.00	

TW   RIGHT BANK LEVEE BETWEEN SECTIONS 3 AND 4

ASQ	QCOMP	TASQ	ERRAC	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
125.92	123.90	125.92	1.62	123.90	1.62	20	26.352	27.981	3.000	4.000

TW   RIGHT BANK FLOODWAY OVER-FLOW WEIR

ASQ	QCOMP	TASQ	ERRAC	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
13041.71	13050.42	13167.63	.07	13167.32	.05	20	24.741	26.352	2.000	3.000

TW   RIGHT BANK LEVEE BETWEEN SECIONS 1 AND 2

ASQ	QCOMP	TASQ	ERRAC	TCQ	TABER	NITER	DSWS	USWS	DSSNO	USSNO
2417.87	2411.49	15585.50	.26	15585.81	.00	20	20.688	24.741	1.000	2.000

```
***********************************
HEC2 RELEASE DATED NOV 76 UPDATED MARC 1982
ERROR CURR - 01,02,03,04,05
MODIFICATION - 50,51,52,53,54,55
***********************************
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THIS RUN EXECUTED   28 MAY 81   13.16.49

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

D FOX RIVER

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10K*S	VCH	AREA	.01
1.000	0.	0.	0.	0.	7000.00	12.10	0.	14.87	49.65	13.34	524.74	993.
1.000	0.	0.	0.	0.	18133.51	18.30	17.91	22.98	49.96	18.22	1228.42	2565.
1.000	0.	0.	0.	0.	24414.50	20.69	0.	26.21	50.24	20.18	1538.61	3444.
2.000	500.00	0.	0.	4.00	7000.00	15.11	0.	16.94	32.13	11.45	740.40	1234.
2.000	500.00	0.	0.	4.00	18133.51	22.50	0.	24.81	22.06	13.62	2009.61	3860.
2.000	500.00	0.	0.	4.00	26832.37	24.74	0.	28.26	28.85	17.04	2480.87	4995.
3.000	400.00	0.	0.	7.10	7000.00	17.26	0.	18.05	20.60	7.16	977.54	1542.
3.000	400.00	0.	0.	7.10	24000.00	24.05	0.	25.67	18.50	10.23	2346.28	5580.
3.000	400.00	0.	0.	7.10	39874.08	26.35	0.	29.43	28.08	14.09	2830.30	7524.
* 4.000	400.00	0.	0.	9.50	7000.00	18.09	18.09	20.87	112.77	13.38	523.20	659.
* 4.000	400.00	0.	0.	9.50	24000.00	25.19	25.19	28.64	64.43	15.67	1881.09	2989.
* 4.000	400.00	0.	0.	9.50	40000.00	27.98	27.98	32.58	67.38	18.74	2719.65	4873.

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D FOX RIVER

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
1.000	7000.00	12.10	0.	0.	8.30	56.36	0.
1.000	18133.51	18.30	6.20	0.	7.30	130.00	0.
1.000	24414.50	20.69	2.39	0.	.69	130.00	0.
2.000	7000.00	15.11	0.	3.00	0.	109.84	500.00
2.000	18133.51	22.50	7.39	4.19	0.	210.00	500.00
2.000	26832.37	24.74	2.24	4.05	0.	210.00	500.00
3.000	7000.00	17.26	0.	2.15	0.	169.90	400.00
3.000	24000.00	24.05	6.79	1.55	0.	210.00	400.00
3.000	39874.08	26.35	2.30	1.61	0.	210.00	400.00
4.000	7000.00	18.09	0.	.83	0.	95.91	400.00
4.000	24000.00	25.19	7.10	1.14	0.	300.00	400.00
4.000	40000.00	27.98	2.80	1.63	0.	300.00	400.00

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SUMMARY OF ERRORS

CAUTION SECNO= 4.000   PROFILE= 1   CRITICAL DEPTH ASSUMED
CAUTION SECNO= 4.000   PROFILE= 1   PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 4.000   PROFILE= 1   20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 4.000   PROFILE= 2   CRITICAL DEPTH ASSUMED
CAUTION SECNO= 4.000   PROFILE= 2   PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 4.000   PROFILE= 2   20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 4.000   PROFILE= 3   CRITICAL DEPTH ASSUMED
CAUTION SECNO= 4.000   PROFILE= 3   PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 4.000   PROFILE= 3   20 TRIALS ATTEMPTED TO BALANCE WSEL

APPENDIX III

GRAPHICAL METHOD FOR SOLVING ISLAND DIVIDED FLOWS

ISLAND SPLIT FLOW

Where an island or other obstruction in the river separates flow into
two or more channels over a substantial length (several cross sections),
the quantity of water passing on each side of the island must be determined
since total energy loss, past the island, must be the same for both sides.

The example in fig. III.1 illustrates how to solve the divided flow
problem graphically. The total discharge is proportioned between the north
and south channels, arbitrarily. The water surface elevation for the total
flow is determined for river mile 10.0, and a water surface profile is
calculated for each assumed discharge through the north channel and through
the south channel. The resulting potential water surface elevations at river
mile 10.8 are plotted in fig. III.2. A "total" discharge curve is obtained
at river mile 10.8 by summing north and south channel discharges for common
water surface elevations. This total flow curve intersects the total river
discharge, 5000 cfs, at elevation 104.32, thereby defining the upstream
water surface elevation. By intersecting the north and south channel curves
at elevation 104.32, their respective discharges can be read from the figure.

PROBLEM:

Using the data for the discharge of 5,000 units tabulated below, determine the water-surface elevation at river mile 10.8 when the water-surface elevation at river mile 10.0 is 100.0. What is the discharge in the channel north of the island?

WATER-SURFACE PROFILES FOR VARIOUS BACKWATER PROFILES

| CROSS SECTION RIVER MILE	PROFILE 1		PROFILE 2		PROFILE 3		PROFILE 4	
	NORTH CHANNEL Q = 1000	SOUTH CHANNEL Q = 4000	NORTH CHANNEL Q = 1500	SOUTH CHANNEL Q = 3500	NORTH CHANNEL Q = 2000	SOUTH CHANNEL Q = 3000	NORTH CHANNEL Q = 2500	SOUTH CHANNEL Q = 2500
10.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
10.2	100.6	101.4	100.8	101.2	101.0	101.1	101.2	101.0
10.4	101.2	102.8	101.6	102.5	102.0	102.2	102.4	102.0
10.6	101.8	104.2	102.4	103.7	103.0	103.3	103.6	103.0
10.8	102.4	105.5	103.3	105.0	104.1	104.5	104.8	104.0
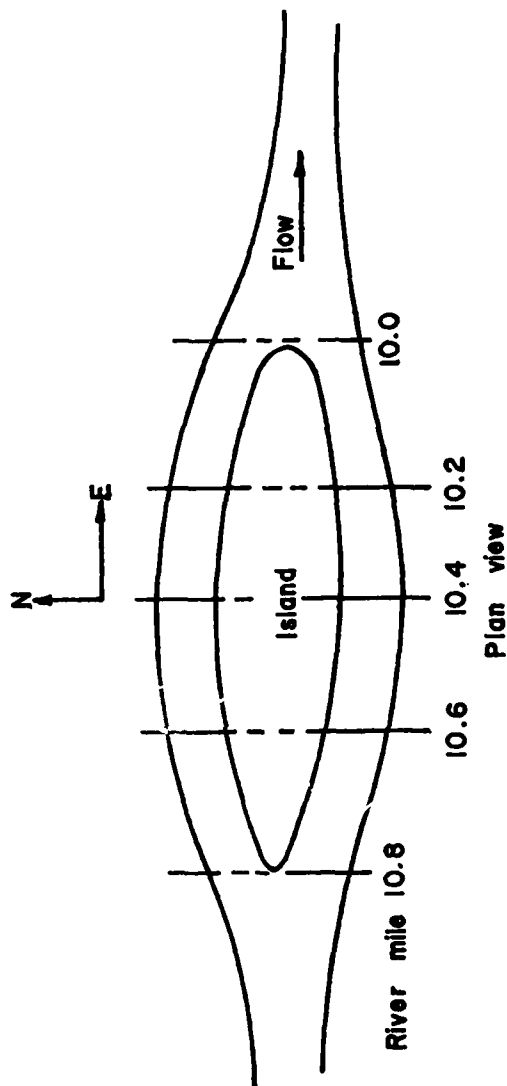
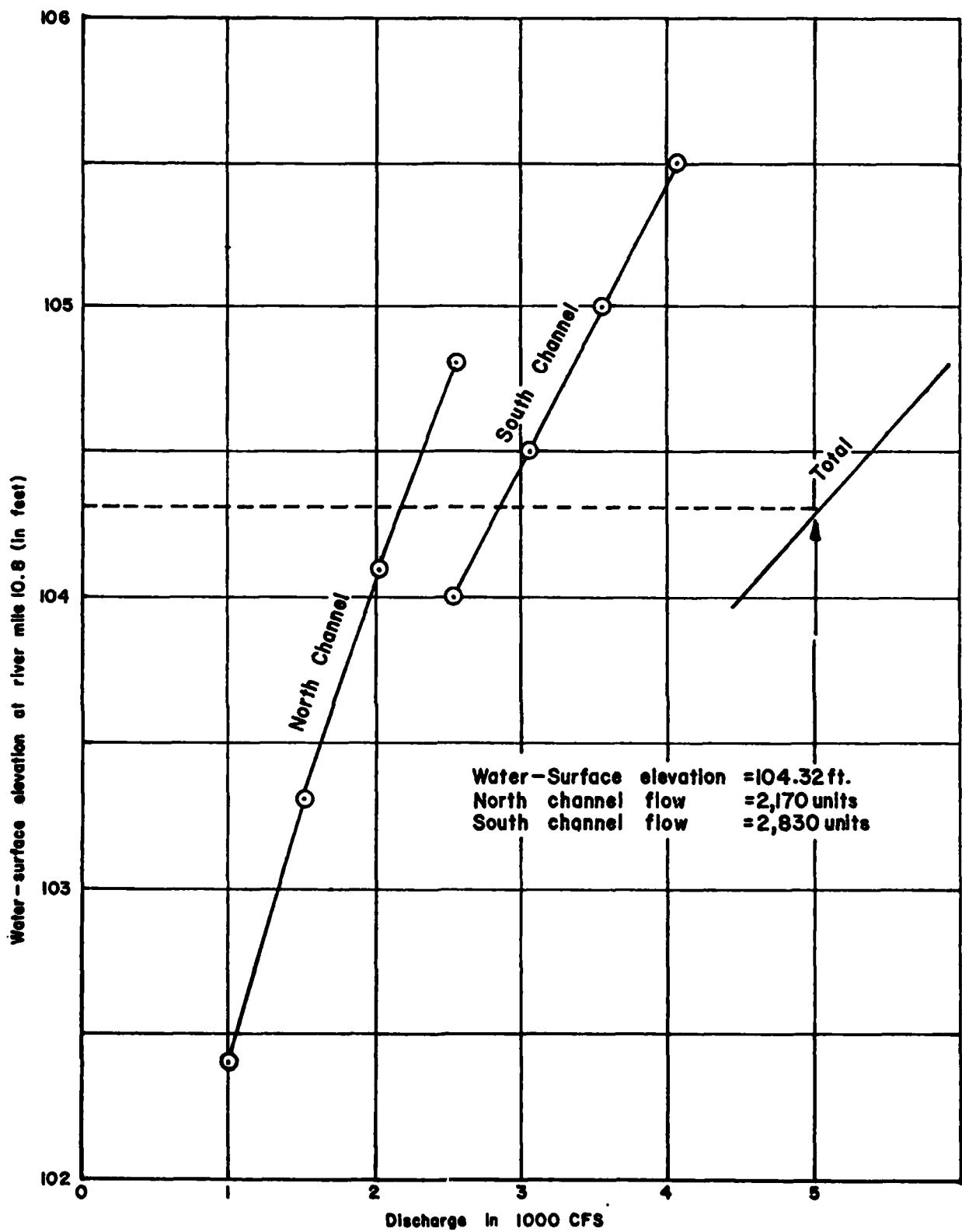Fig. III-1 Example problem for subcritical island type flow computations

Fig. III-2 Graphical interpolation for divided
flow past an island

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
Training document designed to assist the user of computer program HEC-2 split flow option and to acquaint them with its capabilities and limitations. Provide a detailed description of the HEC-2 split flow input requirements, output results, computation method and example applications.